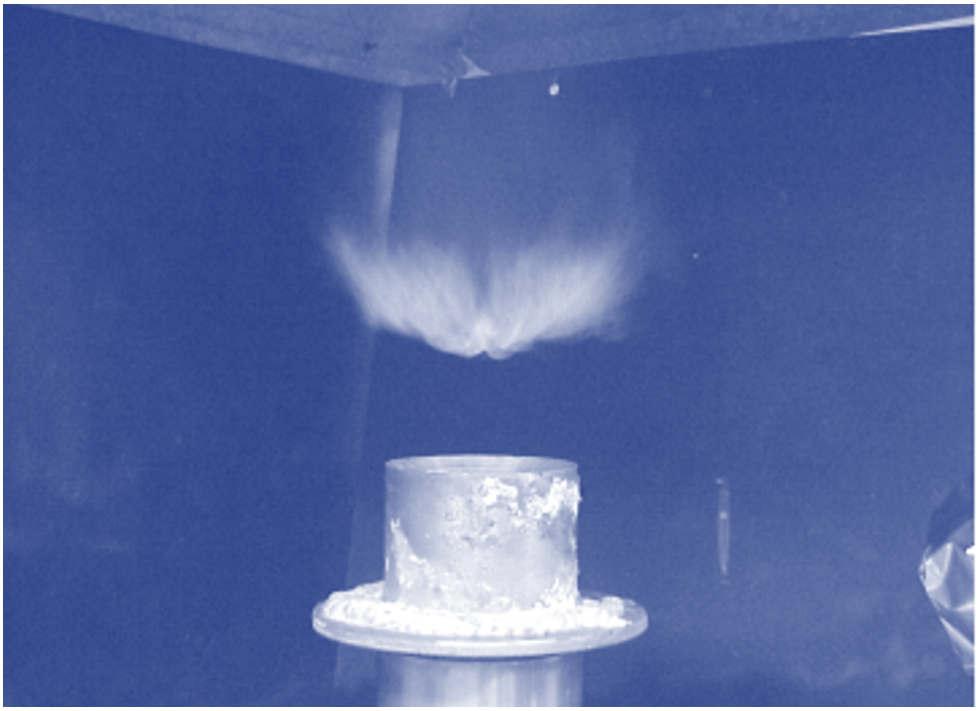
Industrial Technologies Program

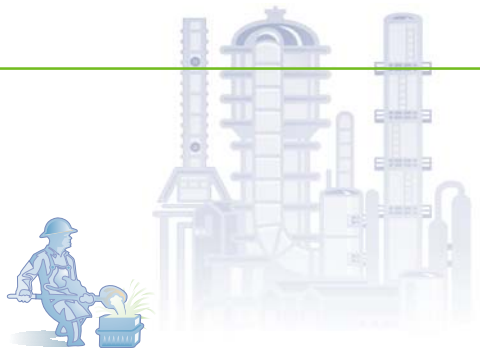
Ultra-Low NOx Burners with Flue Gas Recirculation and Partial Reformer

Process heaters in American manufacturing industries consume roughly 6.7 quadrillion Btu annually-about 38% of all energy used by the manufacturing sector. While significant progress has been made in developing burners to meet the requirements of the 1990 Clean Air Act Amendments, current technologies utilize conventional designs that result in efficiency losses and increased capital, maintenance, and operating costs. In fact, fired heater designs have not changed appreciably in the last 20 years, and few new heaters are built each year. Faced with the prospect of more stringent environmental regulations, industry needs new process heater designs and technologies to increase efficiency, reduce emissions, and improve cost/performance ratios.

The ultra-low NOx burner is a low-swirl burner (LSB) being developed to emit less than 5 volumetric parts per million (vppm) NOx without any efficiency penalties. The burner achieves ultra-low NOx emissions by merging technology advancements in advanced lean premixed burners and fuel pre-treatment. The resulting burner system combines a low-swirl flame stabilization method with internal flue gas recirculation (IFGR). This system is also being optimized to utilize partially reformed natural gas (PRNG).



Low-swirl burner and highly lifted flame.



Benefits

- *Very low NOx emissions of less than 5 ppm.*
- *Reduced developmental, operating, maintenance, and capital costs in comparison to "current generation" low-NOx burner systems*
- *Increased system efficiency, with operation at less than 10 percent excess air over the entire turndown range of at least five to one*
- *Burner design is suitable for new or retrofit applications to a wide range of combustion chamber configurations*

Applications

Steam and process heating applications that rely upon burner technology are used in nearly every manufacturing industry in the United States.

Project Partners

- *Lawrence Berkeley National Lab*
- *Coen Co.*
- *CMC Engineering*
- *John Zink Co.*
- *Gasunie Research*
- *Maxon Corporation*
- *MIT Plasma Science and Fusion Center*

Project Description

This goal of this project is to develop low excess air, ultra-low NOx, natural gas-fired industrial burners. A broader objective of this program is to establish the technical foundation for a combustion method that will achieve less than 5 ppm NOx.

The project will optimize the LSB to capture the benefits of firing with partially reformed natural gas coupled with internal flue gas recirculation (IFGR). Efforts will focus on designing and demonstrating a low-swirl burner with IFGR that can be scaled to large industrial boilers.

The first year's work will focus on defining the design configuration and operating envelope for the LSB to produce the optimum conditions for operation with partially reformed natural gas. Subsequent activities will be the development and evaluation of a low-swirl burner with IFGR up to 2 MMBtu/hr. The burner will then be scaled to larger sizes and its design improved for use with partially reformed gas. Finally, industrial partners will be sought to conduct field demonstrations of the burner technology.

Progress and Milestones

- Collaboration with several OEMs on the evaluation and adaptation of low-swirl burner technology has indicated thus far that the technology is applicable to a wide range of heating systems (50 kBTU/hr to 30 MMBtu/hr).
- Construction and testing of a small LSB with variable swirl numbers was performed to determine the optimum LSB design. Results showed that current swirl number guidelines and scaling equations are adequate.
- Work is currently underway with Maxon Corporation to develop the first commercial low-swirl burner. The burner will have a 1 MMBtu/hr capacity, and a demonstration site in Las Vegas, NV has been selected. Collaboration among the project partners has lead to an LSB which operates at 35% lower pressure than original prototypes without compromising turndown or emissions performance.
- A 5" LSB was reconfigured to generate a highly lifted flame, which helps to counter the noise problem in firetube boilers. By relaxing the swirl number, the flame is more lifted. This burner is currently awaiting further testing.
- Continued development of the LSB/IFGR/PRNG burner system is focused on developing a laboratory demonstration with a new project partner: The Plasma Science and Fusion Center at MIT.

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September 2003